




**Multibeam Acoustic survey of the EPA-  
Designated Ocean Dredged Material  
Disposal Site (LA-5)  
Located Offshore of San Diego, California**

# **Report of Survey**

December 20th 2018


	HYDROGRAPHIC SURVEY	Doc: BATT_2018_LA5_REPORT_OF_SURVEY_A3	
		Rev: A3	Date: 12/20/2018
		Page: 2 of 37	

Contractor Document No: BATT\_2018\_LA5\_REPORT\_OF\_SURVEY\_A3.docx

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	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 3 of 37	


## PRELIMINARY REPORT CONTENTS

EXECUTIVE SUMMARY .....	6
1. INTRODUCTION .....	7
a. Survey Area .....	7
b. Company Overview .....	8
2. OBJECTIVES .....	9
3. METHODOLOGY .....	10
a. Survey Vessels .....	10
b. Equipment .....	11
i. Positioning System .....	11
ii. Multibeam Sonar .....	12
c. Geodesy .....	14
i. Project Coordinates .....	14
ii. Vertical Datum .....	15
iii. Horizontal and Vertical Control .....	15
d. Acquisition and Safety .....	16
e. Processing & Software .....	17
f. Analysis .....	17
g. Geodatabase .....	17
4. RESULTS .....	19
a. Multibeam and Backscatter .....	19
5. ANALYSIS .....	21
a. Disposal Site and Features .....	21
b. Backscatter and Sediment Analysis .....	29
6. CONCLUSIONS .....	35
7. DELIVERABLES AND MOVING FORWARD .....	36
Disclaimer .....	37

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 4 of 37	

## FIGURES

Figure 1 Survey area location .....	7
Figure 2 Starboard side view of the M/V JAB .....	10
Figure 3 Applanix POS MV Oceanmaster.....	11
Figure 4 Location of PLO6 CORS Station .....	12
Figure 5 R2 Sonic 2024 Multibeam Echosounder System .....	12
Figure 6 Details of CORS Station PL06 .....	16
Figure 7 Geodatabase Unique IDs .....	18
Figure 8 Overview of complete Multibeam coverage .....	19
Figure 9 Overview of complete MBES backscatter .....	20
Figure 10 Overview including LA-5 Disposal Site and deactivate disposal site.....	21
Figure 11 Close up of LA-5 Disposal Site.....	22
Figure 12 Overview of the outfall pipe.....	23
Figure 13 Analysis of a subsea trench in the survey area .....	24
Figure 14 An object (OBJ 001) can be seen in the MBES data.....	25
Figure 15 OBJ 001 Cross Section.....	26
Figure 16 The second object (OBJ 002) can be seen in the MBES data .....	27
Figure 17 OBJ 002 Cross Section.....	28
Figure 18 Overview of sediment analysis from backscatter .....	29
Figure 19 Surface sediment changes in backscatter resulting in streaks .....	30
Figure 20 Evidence of pockmarks .....	31
Figure 21 Large irregular sediment mounds.....	32
Figure 22 Surface sediment changes in backscatter resulting in circular features .....	33
Figure 23 Updated sediment map from ground sampling .....	34


	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 5 of 37	

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## **ABBREVIATIONS**

ACSM/THSOA - American Congress on Surveying and Mapping/The Hydrographic Society of America  
 AML - AML Oceanographic Systems  
 CMR+ / CMR 94 – Compact Measurement Record  
 CORS - Continuously Operating Reference Stations  
 GAMS - GNSS Azimuth Measurement System, GAMS™  
 GLONASS - Global Navigation Satellite System  
 GNSS - Global Navigation Satellite System  
 GPS - Global Positioning System (US System)  
 GRS - Geodetic Reference System  
 ID - Identification number  
 LIDAR - Light Detection and Ranging  
 MBES - Multibeam Echo Sounder System  
 MLLW - Mean Lower Low Water  
 NAD83 - North American Datum 1983  
 NAVD88 - North America Vertical Datum 1988  
 NGS - National Geodetic Survey  
 PPK - Post Processed Kinematic  
 QINSy - Quality Integrated Navigation System  
 QC - Quality Control  
 QPS - Quality Positioning Systems  
 RTK - Real Time Kinematic  
 SBET - Smoothed Best Estimate of Trajectory  
 SVP - Sound Velocity Profile(r)  
 USM - Universal Sonar Mount  
 USACE - United State Army Corps of Engineers  
 WGS84 - World Geodetic System 1984

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 6 of 37	

## EXECUTIVE SUMMARY

Between July 24th and 29th 2018 eTrac Inc. completed a hydrographic survey of an area approximately 30 square nm (7nm long and 5nm wide) approximately centered around the EPA-Designated Ocean Dredged Material Disposal Site (LA-5). The survey area covered was as outlined in the Battelle RFP: 18-567 "Multibeam Acoustic survey of the EPA-Designated Ocean Dredged Material Disposal Site (LA-5) and the eTrac response document "BATT\_Technical Approach\_Static TOC\_A3".

The objectives of the survey were as follows:

- 1) Create a bathymetry grid of seabed depths across the area
- 2) Identify, locate and detail debris objects on the seabed
- 3) Determine substrate across the survey area
- 4) Detail extents and changes in sediment type across the survey area
- 5) Detail and describe extents of any marine vegetation within the survey area


Detailed information on the seabed depths were recorded with full coverage multibeam.

The disposal site was clearly visible in the bathymetry and backscatter. Sediment changes were notable throughout the survey area with the aid of the backscatter information.

2 objects were located on the seabed. These ranged from 165ft in length to 190ft. And heights were 4ft to 10ft in height. These objects were identified from multiple passes in the multibeam data as well as from the non-homogeneous features of the surrounding seabed.

The South Western section of the survey area contained a notable canyon that was about 300ft deep and upwards of 4000ft wide.

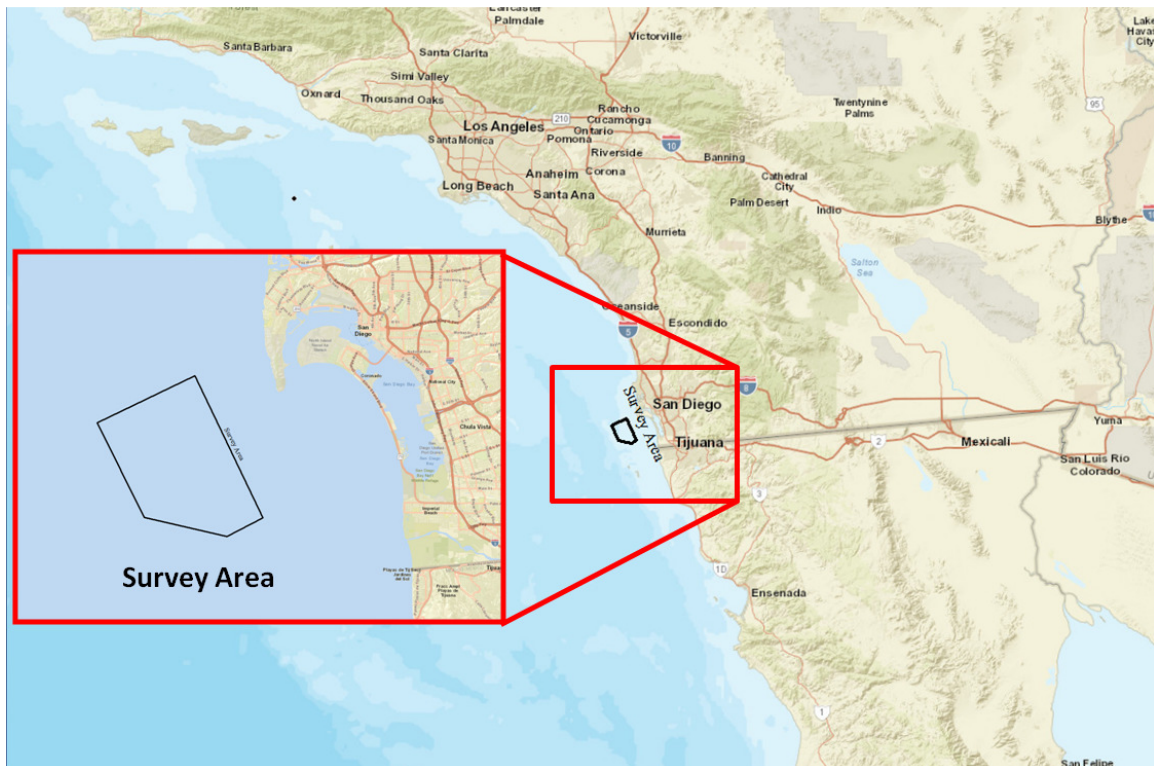
Various sediment differences were noted from the backscatter dataset.

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 7 of 37	


# 1. INTRODUCTION

## *a. Survey Area*

This report is prepared for Battelle (Battelle) by eTrac Inc (eTrac) as part of the deliverables for the 18-567 Multibeam Acoustic survey of the EPA-Designated Ocean Dredged Material Disposal Site (ODMDS) LA-5 Located Offshore of San Diego, California, EPA WA4-09 - LA-5 ODMD Site Monitoring Survey. Figure 1 shows the project area. The survey area was designated by Battelle as detailed within the RFP 18-567. Coverage was obtained up to the border offshore and then along shore as close as possible where maintaining safe survey conditions.




**Figure 1 Survey area location**

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 8 of 37	

## ***b. Company Overview***

eTrac Inc. was established in 2003 as a hydrographic and geophysical surveys, vessel positioning and instrumentation firm. eTrac has several offices along the US West Coast including San Francisco, Seattle and Anchorage. The firm has earned a strong reputation among many sectors of the hydrographic industry, including government agencies and private industry. Its equipment fleet has also grown to include 9 aluminum geophysical survey vessels as well as several ultraportable, shallow water survey craft. eTrac's role has grown over the years to include a strong group of full-time staff as well as several localized vessels to support the work required by USACE, marine construction, engineering firms and petroleum industry contractors on the west coast. eTrac is committed to continual re-investment in industry leading equipment and knowledgeable staff to complete multibeam, singlebeam, sidescan, mobile LiDAR and water-level surveys required by our clients. Staffed with professionally licensed land surveyors and ACSM/THSOA (American Congress on Surveying and Mapping/The Hydrographic Society of America) certified hydrographers, eTrac's projects are performed at the highest level of quality and detail that the industry demands.




	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 9 of 37	

## 2. OBJECTIVES

eTrac completed a hydrographic survey covering the designated survey area. The objectives of the survey were as follows;

- 1) Collect bathymetry data in 50 to 350 meters of water depth and identify any special or unexpected features that would interfere with sediment sampling.
- 2) Run transect lines that result in high resolution MBES collection to delineate from the dredge material footprint and bottom features.
- 3) Meet a minimum of 1x1 m inshore MBES density and a minimum of 10x10 m offshore density.
- 4) Survey collected in no more than 4 days.
- 5) Survey operations needed to be completed 2 weeks prior to sediment sampling by EPA/Battelle.
- 6) Calibration of the MBES system.
- 7) Provide preliminary maps and a survey summary within 2 weeks of the MBES survey.
- 8) Provide raw data in XYZ Comma delimited ASCII data sorted at depth appropriate gridding.
- 9) Provide a Geodatabase that includes Backscatter, ArcGIS Terrain generated from bathymetry, Bathymetric hill shaded from gridded surface, Bathymetric hill shade from a surface interpolated over the gaps.
- 10) Bathymetric and Backscatter Maps of the survey area and a surficial sediment map.

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 10 of 37	


### 3. METHODOLOGY

#### a. Survey Vessels

All work was completed onboard survey vessel *M/V Jab*. The JAB is a 44' Armstrong Marine Jet Powered Aluminum Catamaran that drafts 2.5 ft. The Vessel is equipped with a shock mounted computer rack, moonpool multibeam mount, antenna mounts, monitor mounts, dedicated mounting space for an IMU.



**Figure 2 Starboard side view of the M/V JAB**

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 11 of 37	

## ***b. Equipment***

### **i. Positioning System**


A highly accurate, inertial motion and positioning system was used for vessel positioning. The system, an Applanix POS MV V4 Oceanmaster is an integrated position and motion system. It measures all vessel movement including heading and integrates accurate position and timing to provide an entire solution of the position of any sensor on board the vessel. The system was upgraded in 2017 to contain the same hardware as a V5 system within the operating CPU. The system has an integrated, internal WAAS, DGPS system which was used for online acquisition. All vessel position and motion data was logged so that a highly accurate (~3cms) post processed kinematic position solution could be applied to the sensor data.

#### **Applanix POS MV V4 Oceanmaster**

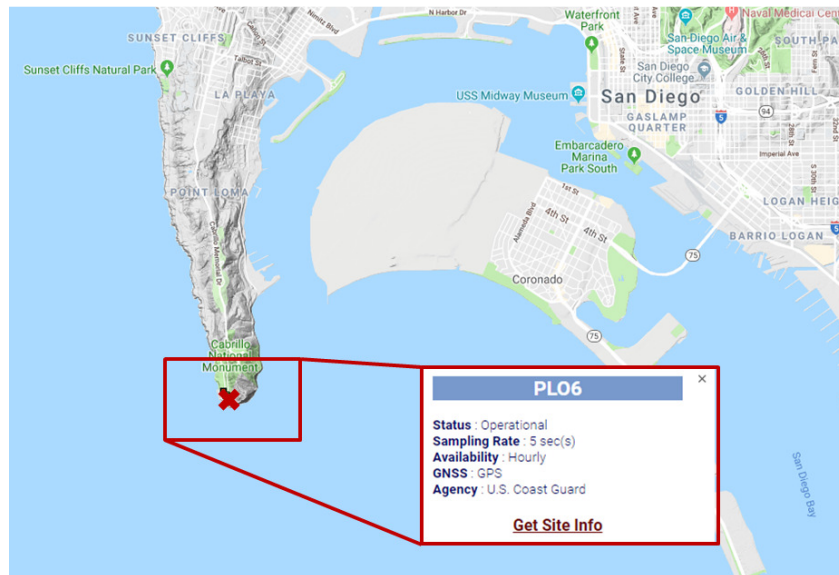
- Position Accuracies PPK: Horizontal: +/- (8 mm + 1 ppm x baseline length)<sup>3</sup>  
Vertical: +/- (15 mm + 1 ppm x baseline length)
- Motion Accuracies, Roll and Pitch: 0.015° in PPK
- Heading Accuracies: 0.03° (2 m baseline)
- Real time Heave 5cms and Trueheave Solutions available increasing to 3cms
- With POSPac Processing allows PPK solution with GLONASS AND GPS satellites.



**Figure 3 Applanix POS MV Oceanmaster**

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 12 of 37	

A Continuously Operation Reference Station (CORS) GPS was used for the Post Processing of the Realtime data for an SBET solution. The CORS station used was PLO6, which is located near Point Loma as seen in Figure 4. PLO6 is a 5 second station operated and managed by the US Coast Guard. The PLO6 CORS station has been used on various occasions by eTrac Inc therefore confirming its reliability through repeated uses throughout the San Diego Bay Region. Every 24hrs a base file is available for download from the station.



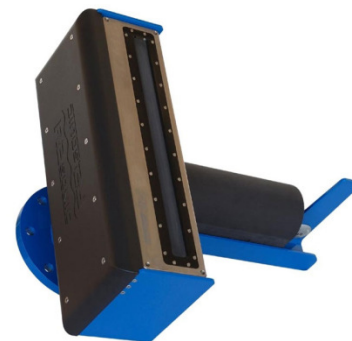
**Figure 4 Location of PLO6 CORS Station**

The corrections from PLO6 were used offline to create the post processed kinematic (PPK). The solution for the post processed vessel position and motion were supplied by the NGS CORS (Continuously Operating Reference Station).


## ii. Multibeam Sonar

### R2Sonic 2024 Multibeam Echo sounder

- 170-700 kHz
- 256 discrete 0.5° x 1.0° beams (1024 soundings with ultra high density mode implemented)
- 1 to 500 meter minimum/maximum range
- 1.25 cm range resolution




**Figure 5 R2 Sonic 2024 Multibeam Echosounder System**

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 13 of 37	

An R2 Sonic 2024 multibeam system was used for all data. The system was run at 700khz and 450khz in ultra high density mode. This allowed sounding data density to be four times that of the standard R2 sonic 2024 system. The system was run with no gates or filters to enable imagery of all potential objects in the entire water column.

For all multibeam data the sound speed both that the sonar head and through the water column was accounted for with two sound velocity probes. An AML Micro X and AML Base X were used.

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 14 of 37	

## **c. Geodesy**

### **i. Project Coordinates**


The project coordinates used for the survey were NAD83 U.S. State Plane California Zone 6 in US Survey feet.

#### **Spheroid Parameters**

Geodetic Datum	NAD 1983 (2011) 2010.00
Ellipsoid	GRS 1980
Semi-major Axis	20925604.474 USft
Inverse Flattening (1/f)	298.257222101

#### **Projection Parameters**

Description	US State Plane California Zone 6
Unit	US survey Feet
Projection	Lambert Conic Conformal (Two Standard Parallels)
Latitude of Origin	32° 10 00.00 North
Longitude of Origin	116° 15 00.00 West
Scale Factor	1.0
Grid Easting at Origin	6561666.667
Grid Northing at Origin	1640416.667
Scale Factor at longitude of Origin	1.0

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 15 of 37	

## ii. Vertical Datum


The vertical datum for all work was MLLW.

## iii. Horizontal and Vertical Control

The horizontal and vertical control for the project is the NGS Benchmark "" NGS CORS Station PLO6 (see Figure 4 for location and Figure 6 Details of CORS Station PL06 for coordinates). The base station and benchmark are 18 miles from the furthest extent of the survey area.

An OPUS solution was calculated for the CORS data and benchmark using data from July 25th. This created the most up to date positioning of the benchmark relative to NAD83 (2011) . This position was held for the entire survey. Corrections from the CORS station were applied to logged vessel data to compute a Post Processed Kinematic position and motion for the vessel. Data was reduced from ellipsoidal to orthometric height NAVD88 using Geoid 2012B.

To further reduce the data from NAVD88 to MLLW a comparison between Vdatum calculations and the NOAA tide Station 9410230 “La Jolla”. The comparisons showed the Vdatum reduction from NAVD88 to MLLW was in line with a reduction of NAVD88 to MLLW at the NOAA station. Vdatum showed a nominal difference (less than 0.07ft) between MLLW and NAVD88 within the survey area.

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 16 of 37	

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National Geodetic Survey,  Retrieval Date = DECEMBER 19, 2018
*****
CORS          -  This is a GPS Continuously Operating Reference Station.
DESIGNATION   -  POINT LOMA 6 CORS ARP
CORS_ID       -  PL06
PID           -  DI0896
STATE/COUNTY  -  CA/SAN DIEGO
COUNTRY       -  US
USGS QUAD     -  POINT LOMA (1994)

                *CURRENT SURVEY CONTROL

NAD 83(2011) POSITION- 32 39 56.20904(N) 117 14 35.39301(W)  ADJUSTED
NAD 83(2011) ELLIP HT-  -21.684 (meters)          (08/??/11)  ADJUSTED
NAD 83(2011) EPOCH   - 2010.00

GEOID HEIGHT   -  -35.504 (meters)                GEOID12B
NAD 83(2011) X   - -2,460,302.183 (meters)          COMP
NAD 83(2011) Y   - -4,778,372.204 (meters)          COMP
NAD 83(2011) Z   - 3,422,786.963 (meters)          COMP

Network accuracy estimates per FGDC Geospatial Positioning Accuracy
Standards:
      FGDC (95% conf, cm)      Standard deviation (cm)      CorrNE
      Horiz  Ellip            SD_N   SD_E   SD_h            (unitless)
-----
NETWORK    3.00  10.54          1.29   1.16   5.38          0.00095600
-----

```


Figure 6 Details of CORS Station PL06

#### ***d. Acquisition and Safety***

The vessel and equipment was mobilized between July 20th and July 23rd 2018. All data was collected from July 24th to July 29th 2018. Data was collected in a safe and efficient manner. Data was collected in daylight hours and in conditions with moderate swell.

All personnel involved with the project are OSHA certified and at the start of the day and before any activity change a full toolbox talk was completed. The main risk involved was deploying and retrieving the sonar head. Two people were always on deck during these operations and retrieval and it was always done at periods during which ample time could be allowed for the process to be done in a safe manner.



	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 17 of 37	

### ***e. Processing & Software***

All multibeam data acquisition was completed in QPS QINSy hydrographic data acquisition, navigation and processing software package. Change in the sound speed environment were monitored and appropriate actions in terms of further measuring of the water column sound speed were taken. Position data was post processed in Applanix POS Pac Inertial post position processing software. This allowed the creation of a more accurate and robust Smoothed Best Estimate of Trajectory (SBET) solution. This refined, highly accurate post processed position and motion was applied to the multibeam data in QPS QIMERA software. Data was then analyzed, further processed for positional errors and cleaned in QIMERA. Quality Checking the data was accomplished by comparing a previous survey in the same area against the data collected during July 24<sup>th</sup> to July 30<sup>th</sup>.

### ***f. Analysis***


The multibeam data was analyzed as both 3D gridded surfaces and 3D point cloud visualization environments. This allowed a detailed understanding of the feature geometries. This data was interpreted in order to determine the existence of debris objects, trenches, outfall pipes and pockmarks.

Notable objects were determined as features that were anomalous to the surrounding seabed. Anything that protruded from the seabed or created a relief, that was not in common with the prevailing bathymetry in the area, was noted or analyzed further.

The outfall pipeline was also analyzed during the survey efforts to establish that there was no sediment or physical changes to the surrounding areas.

### ***g. Geodatabase***

A geodatabase was made to store all the findings. These are referenced by year and type of object or cable found in order that if there are any further developments change can be noted. Each feature is given a unique id code Figure 7 Geodatabase Unique IDs.

	HYDROGRAPHIC SURVEY	Doc: BATT_2018_LA5_REPORT_OF_SURVEY_A3	
		Rev: A3	Date: 12/20/2018
		Page: 18 of 37	

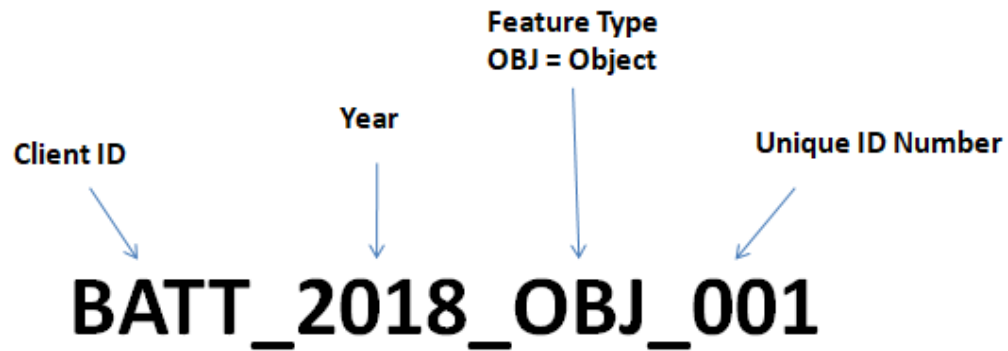
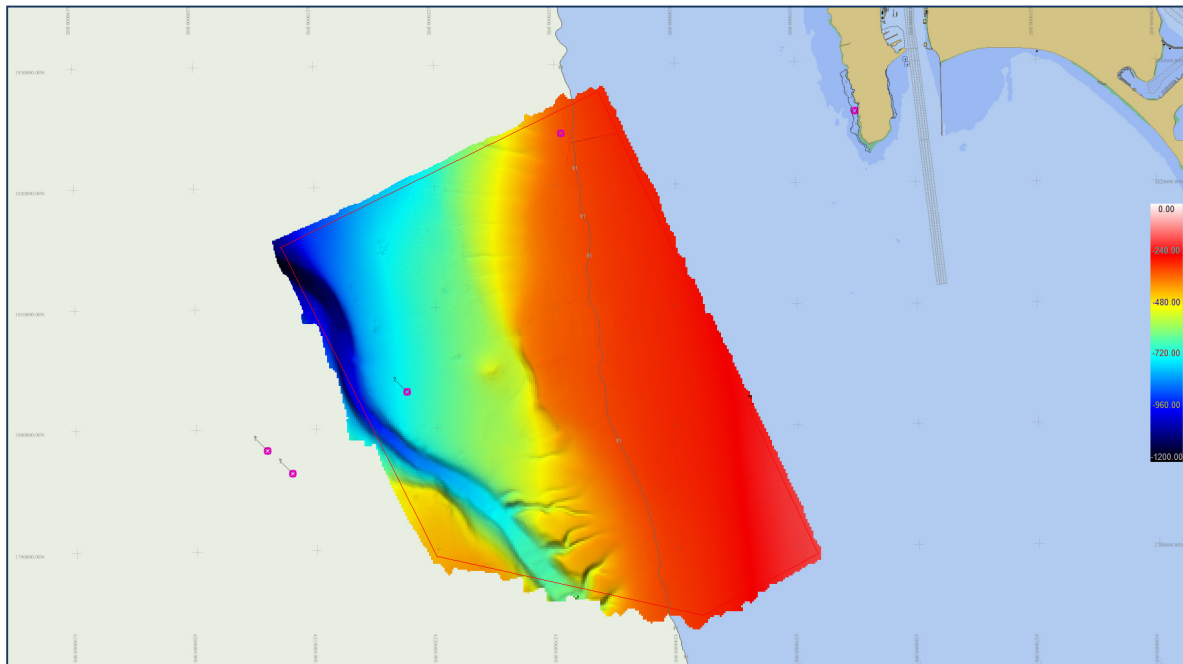


Figure 7 Geodatabase Unique IDs

## 4. RESULTS


### *a. Multibeam and Backscatter*

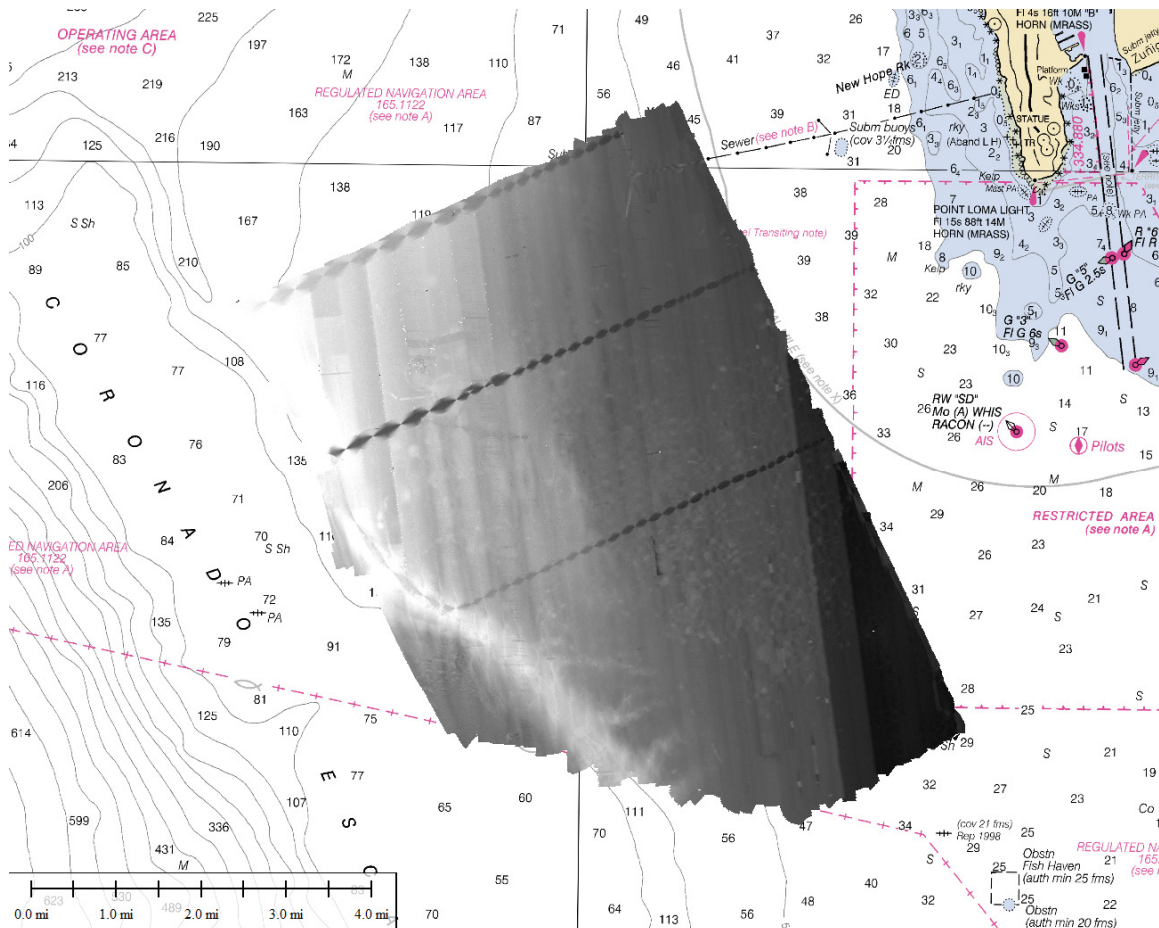
120% multibeam coverage was achieved in entire survey area. All the position data was successfully post processed so that up to 100% of the data was post processed kinematic where accuracies of 0.1ft were achieved.



**Figure 8 Overview of complete Multibeam coverage**

Complete Bathymetric coverage is shown in Figure 9. The overview is relief shaded from the observable depth ranges of 170ft to 1200ft MLLW. Derived from the imagery is a subsea canyon, as well as the LA-5 Disposal site and an outfall pipe.

	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
	Rev: A3	Date: 12/20/2018
	Page: 20 of 37	



**Figure 9 Overview of complete MBES backscatter**

Figure 9 is an overview of the backscatter derived from the Multibeam survey. The most obvious feature seen is that of the subsea canyon. Other notable segments are the small streaks and circular features that occur throughout the survey area.

## 5. ANALYSIS

This section will cover the LA-5 Disposal Site, features/objects found in the dataset, and backscatter Sediment analysis.

### *a. Disposal Site and Features*

The LA-5 Disposal site was observed being 90ft high in about 500 to 610ft of water depth. The disposal site had no apparent difference in sediment form it's surrounding as analyzed from the backscatter data. The overview can be seen in Figure 14 and a close up is found in Figure 15.

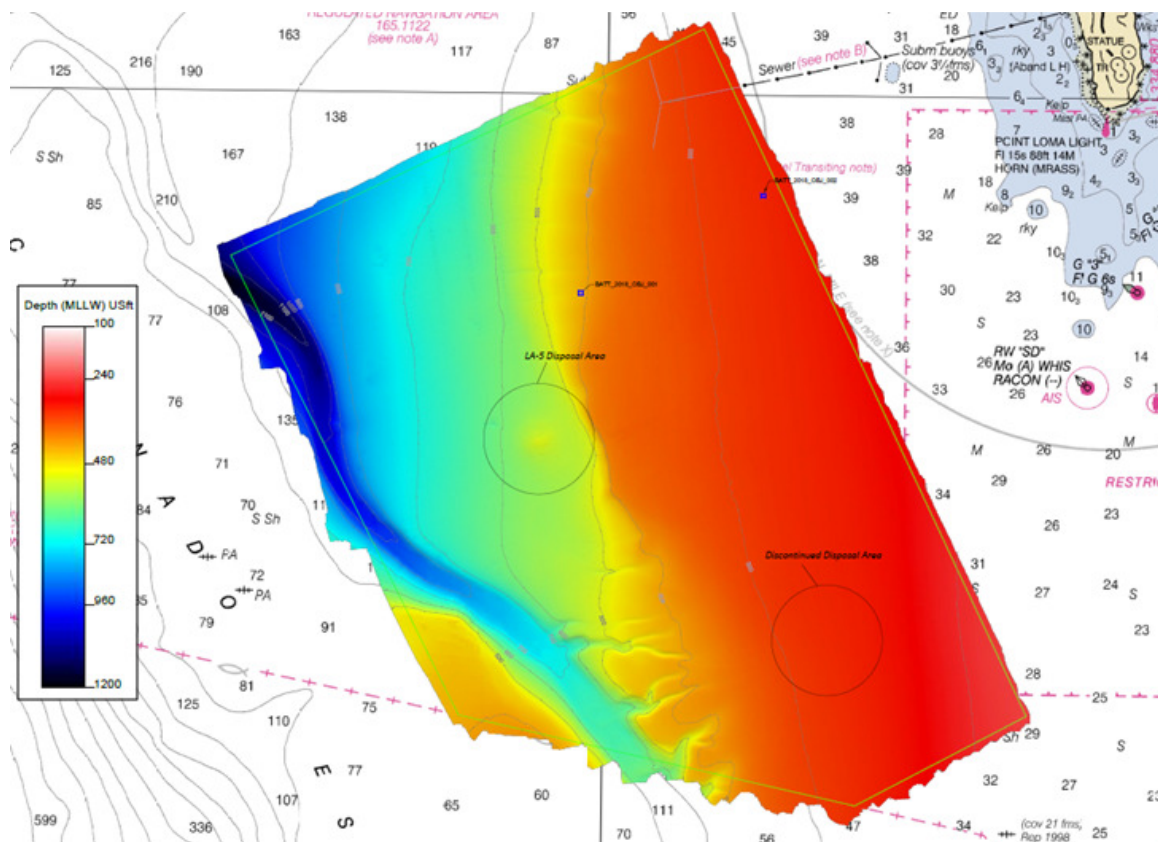
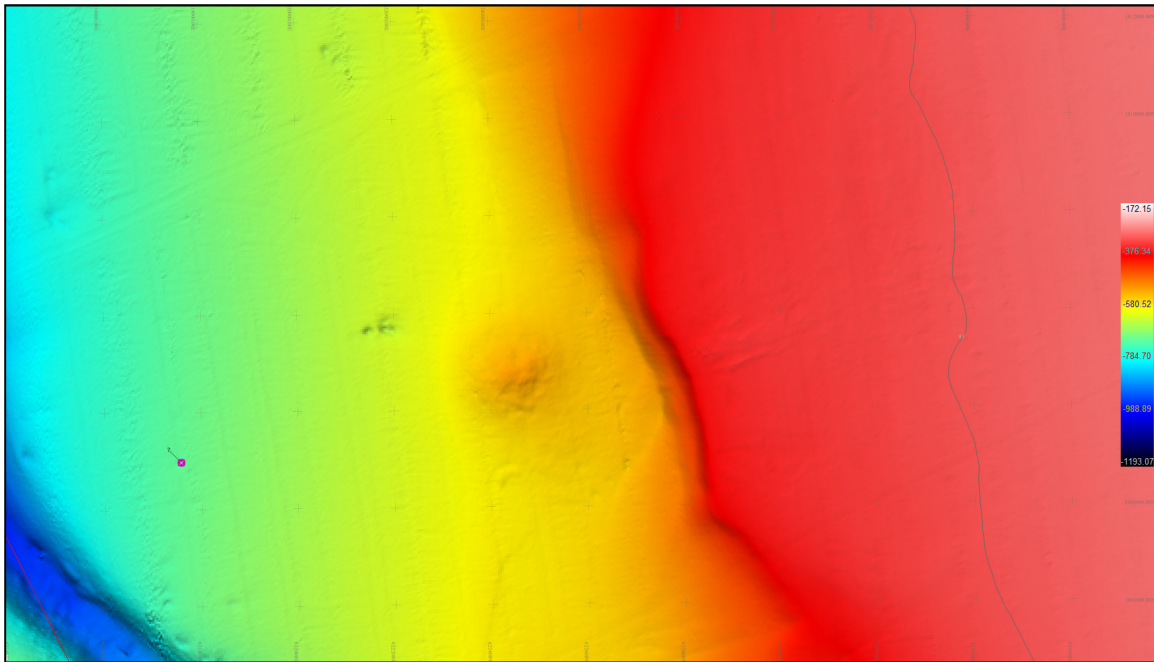
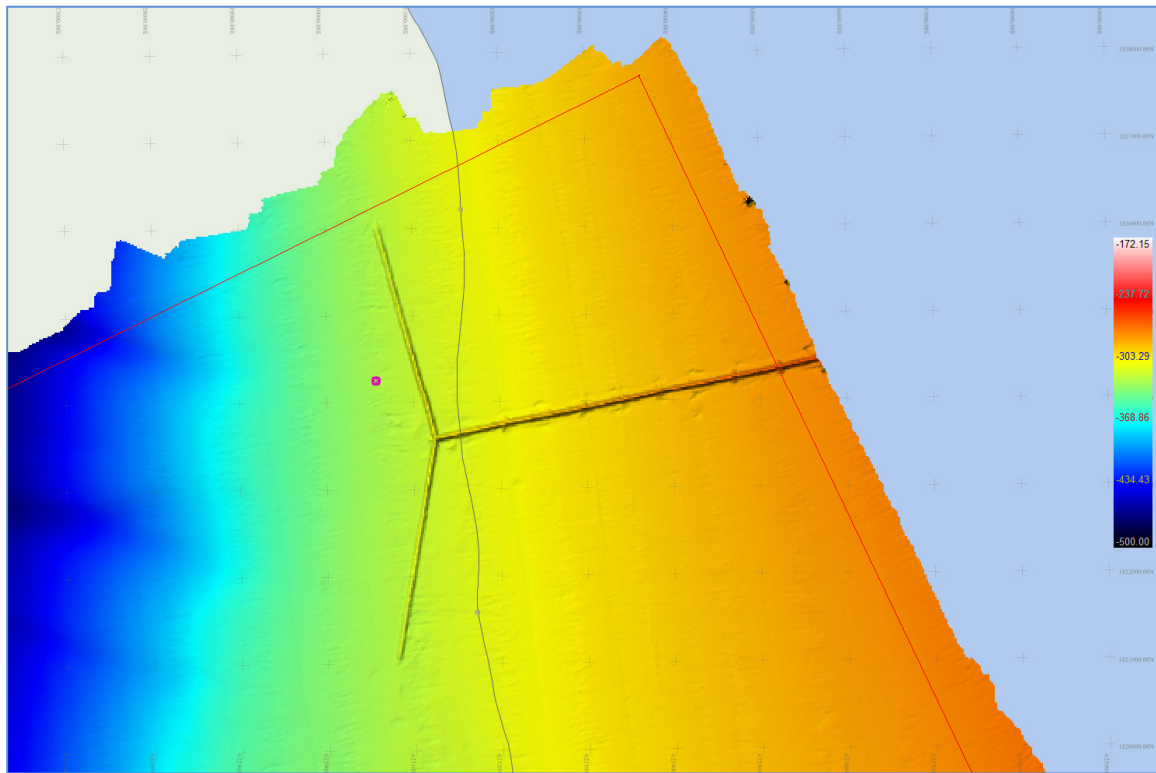


Figure 10 Overview including LA-5 Disposal Site and deactivate disposal site



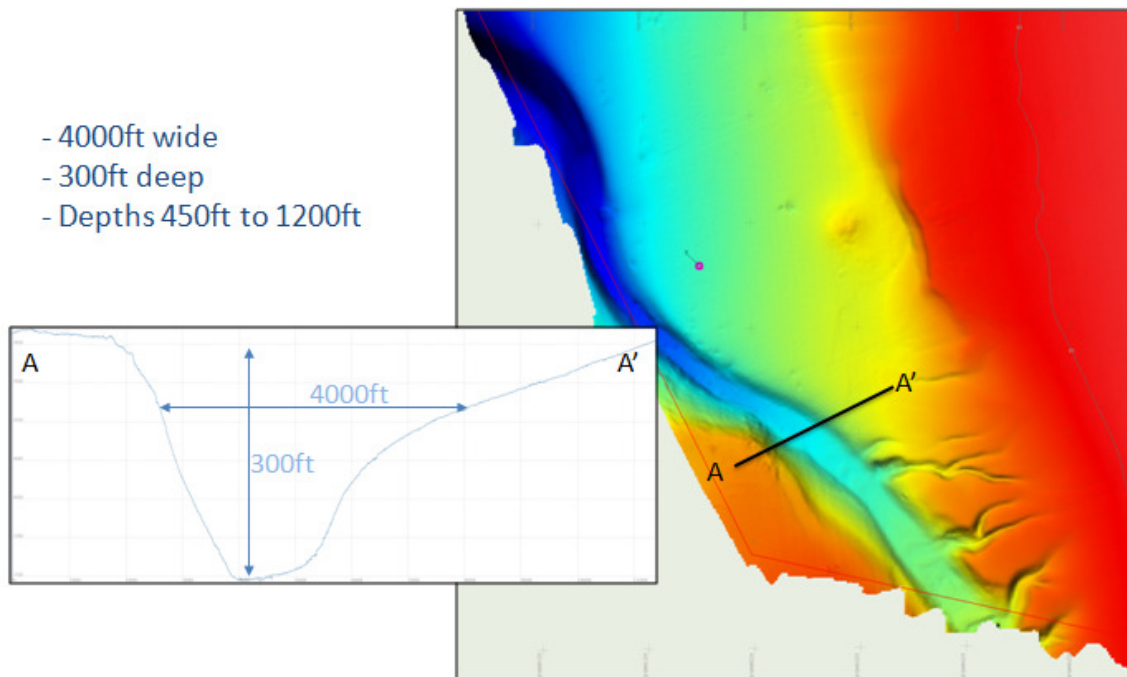
**Figure 11 Close up of LA-5 Disposal Site**





**Figure 12 Overview of the outfall pipe**

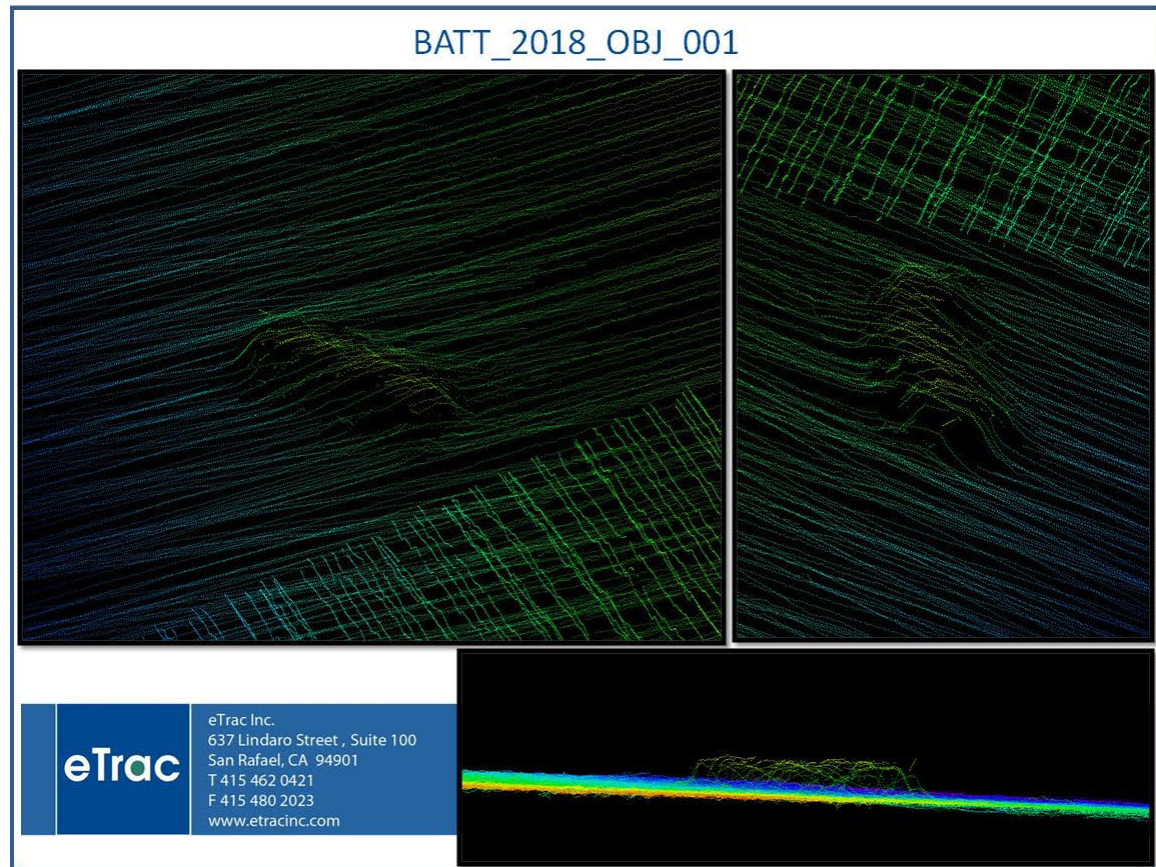
The Outfall pipe was clearly seen in the Multibeam data in depths of 300ft. There was no obvious change in the sediment types near the outfall pipe (backscatter analysis). This can be seen in Figure 16.



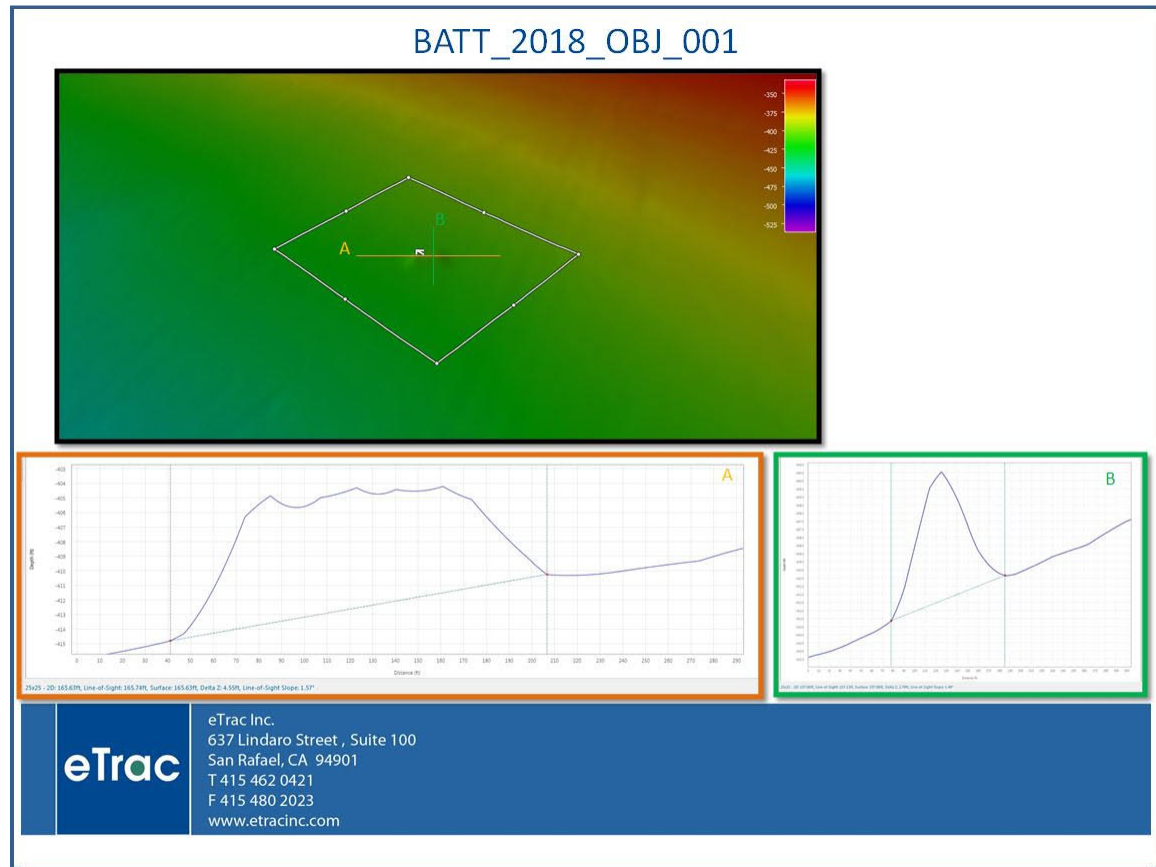
**Figure 13 Analysis of a subsea trench in the survey area**

In Figure 17 a Subsea Canyon was identified. The dimensions of the observable portions of the canyon were 4000ft wide and about 300ft deep. The canyon was surveyed in the depths of 450ft to 1200ft.





**Figure 14** An object (OBJ 001) can be seen in the MBES data

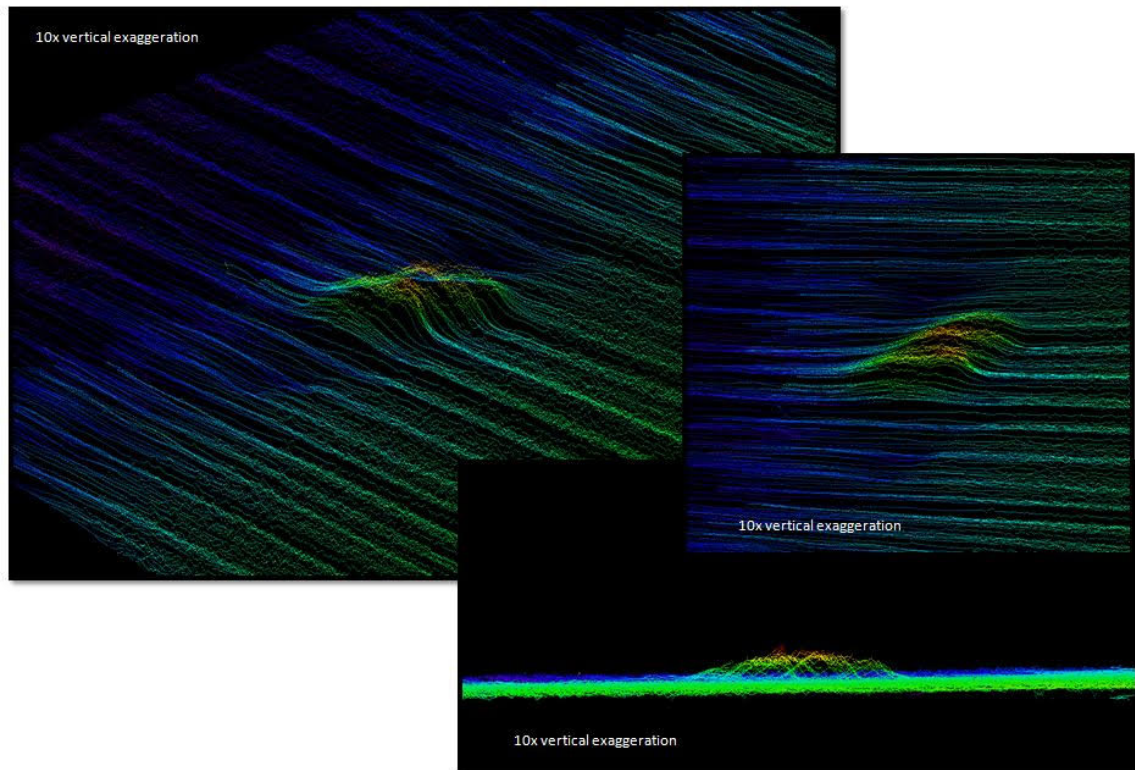


**Figure 15 OBJ 001 Cross Section**

The first object found, OBJ 001, was discovered about 1.5ft North East of the disposal site. The objects dimensions were 164'x100'x9'ft, and it was rectangular. From Figure 10 and Figure 11 you can see that is largely inconclusive what the object is.

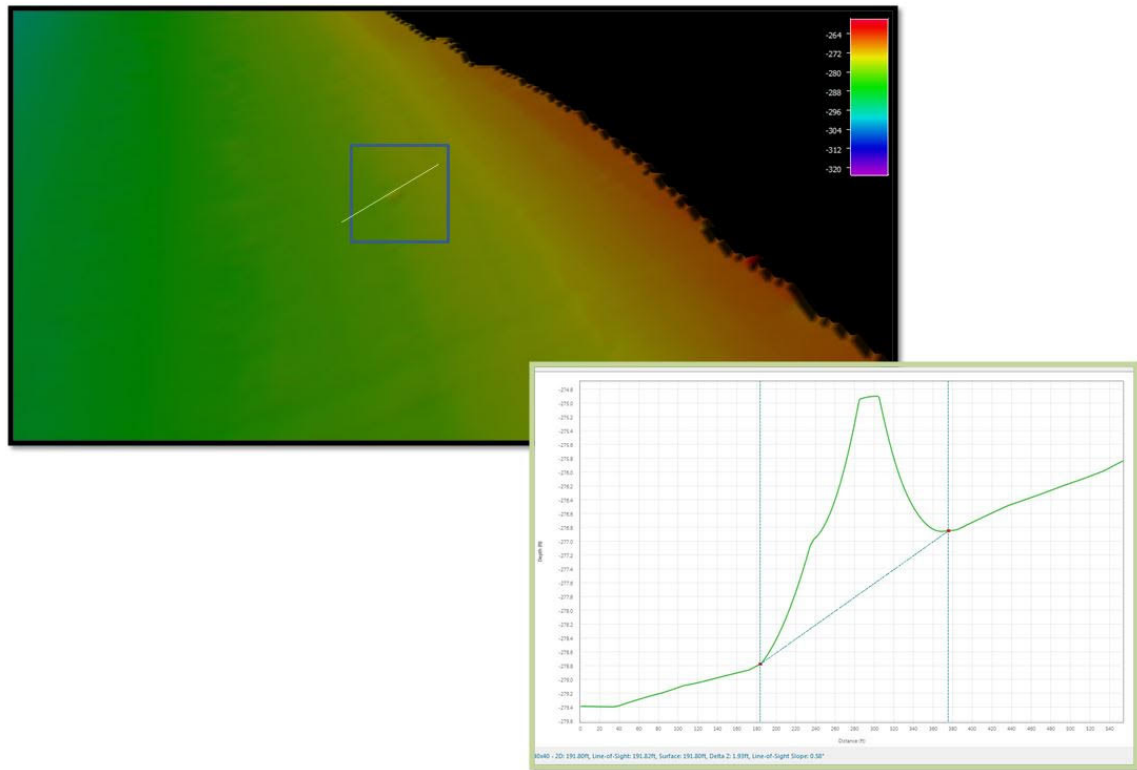
<b>BATTELLE</b> eTrac	HYDROGRAPHIC SURVEY	Doc: BATT_2018_LA5 REPORT OF SURVEY_A3	
		Rev: A3	Date: 12/20/2018
		Page: 27 of 37	

## BATT\_2018\_OBJ\_002



**Figure 16** The second object (OBJ 002) can be seen in the MBES data

## BATT\_2018\_OBJ\_002

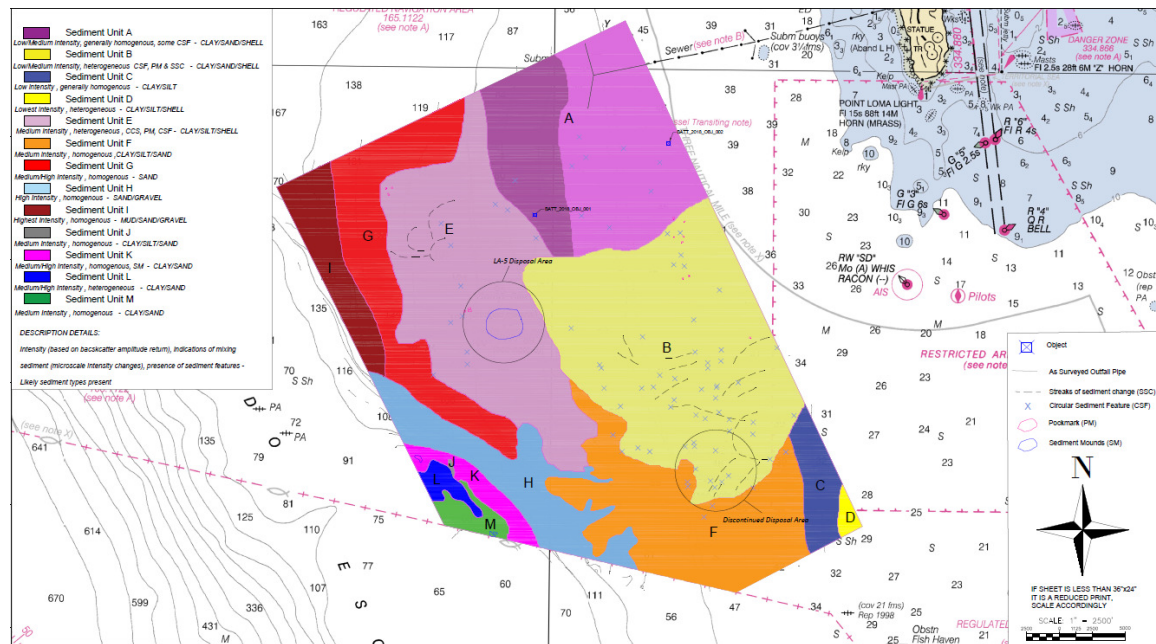


**Figure 17 OBJ 002 Cross Section**

The second object, OBJ 002, was discovered a greater distance from the disposal site, approximately 3.5 miles North East. The object measured 191'x94'x3'ft in a rectangular pattern. Figure 12 and Figure 13 show OBJ 002, though its identity is also largely inconclusive.

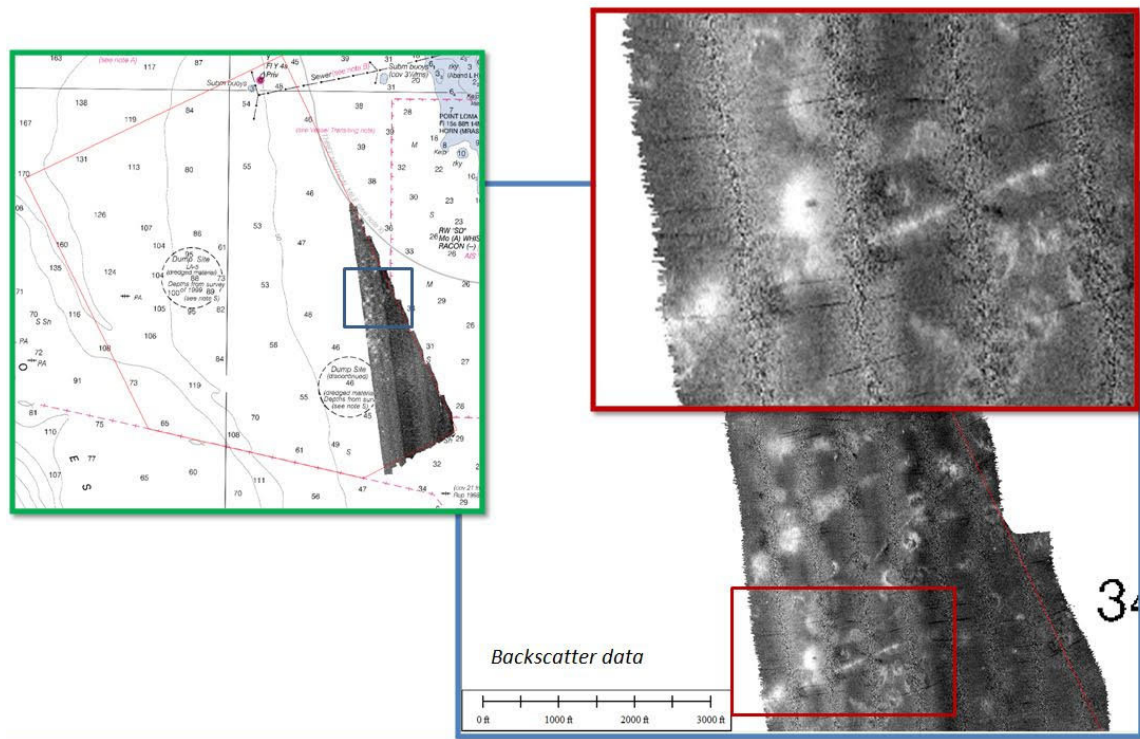


## ***b. Backscatter and Sediment Analysis***



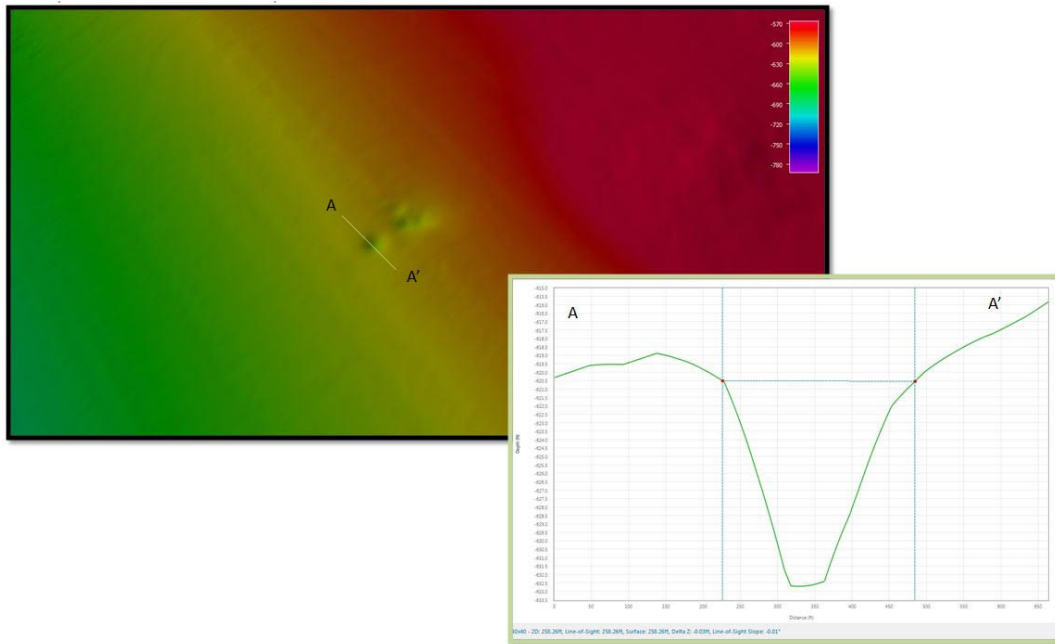
**Figure 18 Overview of sediment analysis from backscatter**

The backscatter data provided enough information to distinguish between 13 sediment units. An estimation of the sediment types was made based on the backscatter return as well as details from NOAA sampling job H08979 and 297Velero. The dotted lines are streaks of sediment change.



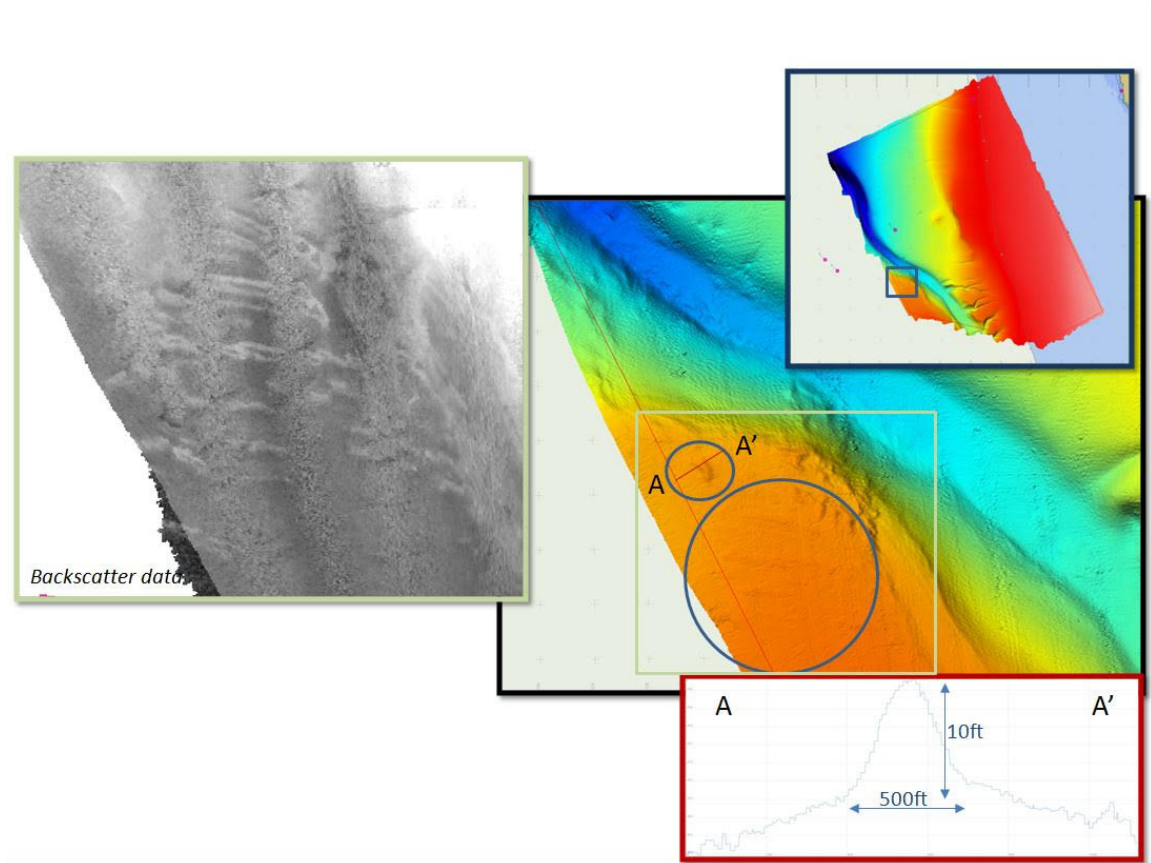
**Figure 19 Surface sediment changes in backscatter resulting in streaks**

Several areas of surface sediment changes were discovered in the backscatter data. These changes were not evident within the bathymetric data as they had no relief changes. There were 1500ft to 2500ft long and upwards of 40ft wide.



**Figure 20 Evidence of pockmarks**

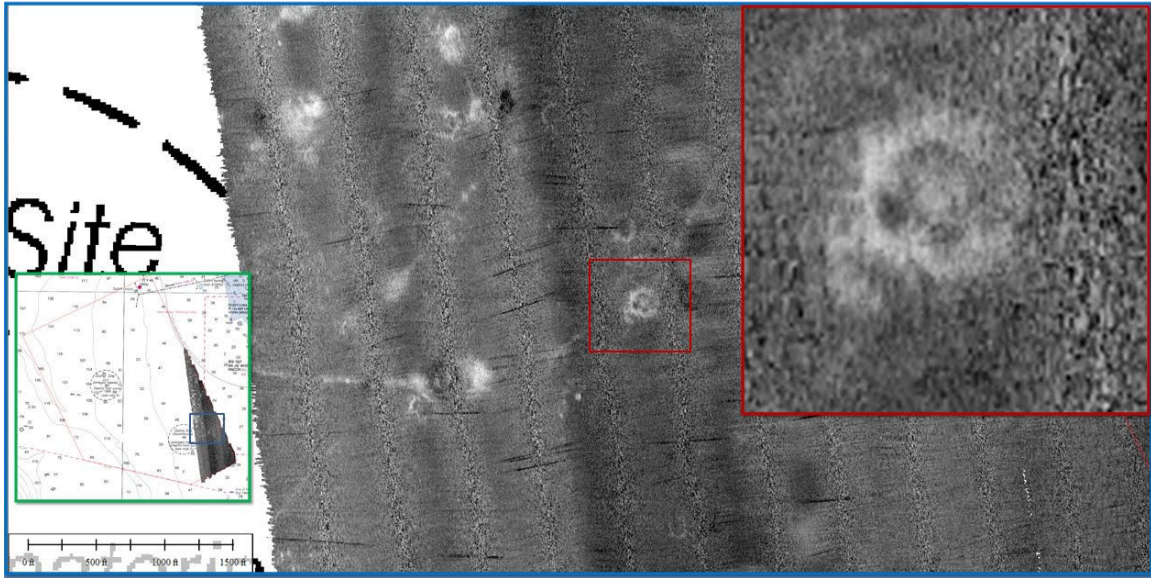
Figure 19 shows apparent signs of pockmarks that were visible in the bathymetric data. There were upwards of 20 individual pockmarks noted. These pockmarks were up to 15ft deep and 150ft in diameter.



**Figure 21 Large irregular sediment mounds**

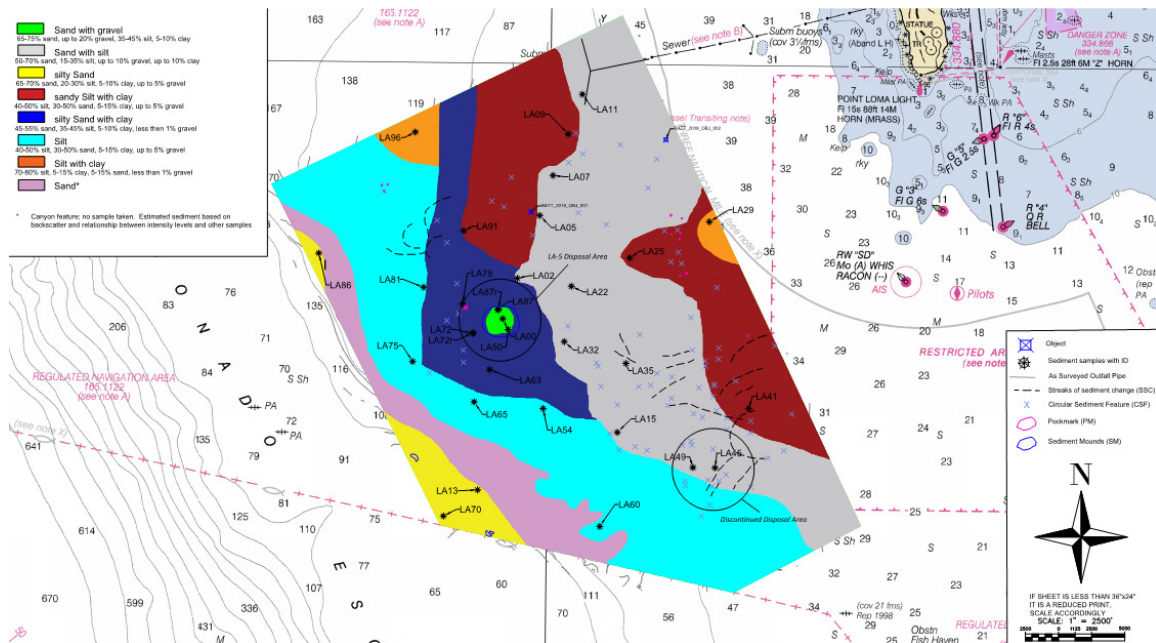
Another notable sediment feature was the section of mounds seen in Figure 21. These mounds were irregularly shaped and were evident in both the bathymetry and backscatter datasets. At their largest there were up to 10ft high and 500ft wide.





**Figure 22 Surface sediment changes in backscatter resulting in circular features**

The final sediment change of significance was not visible in the bathymetry, but once again, clearly distinguishable in the backscatter. Therefore it can be ascertained that this is a surface sediment change. These circular patterns were 350ft in diameter and over 50 were noted in the area. They were most notable in the areas of sandy silt. .




**Figure 23 Updated sediment map from ground sampling**

After the Multibeam survey collection and processing efforts of eTrac, Battelle/EPA collected various bottom samples throughout the Survey Area. The map in Figure 23 is a sediment map based on the various ground samples collected. Grain size results were grouped using percentage cut offs based on the ASTM\_D\_2487 sampling groups. The sediment classification and related grain size percentage is shown below in Table 1.

**Table 1 Grain size percentage and sediment classification**


Sediment Classification	Grain size percentage of sample
Sand with gravel	65-75% sand, up to 20% gravel, 35-45% silt, 5-10% clay
Sand with silt	50-70% sand, 15-35% silt, up to 10% gravel, up to 10% clay
silty Sand	65-70% sand, 20-30% silt, 5-10% clay, up to 5% gravel
sandy Silt with clay	40-50% silt, 30-50% sand, 5-15% clay, up to 5% gravel
silty Sand with clay	45-55% sand, 35-45% silt, 5-10% clay, less than 1% gravel
Silt	40-50% silt, 30-50% sand, 5-15% clay, up to 5% gravel
Silt with clay	70-80% silt, 5-15% clay, 5-15% sand, less than 1% gravel

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 35 of 37	

## 6. CONCLUSIONS

The conclusions for the LA-5 Multibeam survey are as follows:


- All data was acquired in a safe manner with no incidents
- 120% Coverage was achieved across the entire survey area.
- Data acquired achieved all the objectives required.
  - Creating accurate and detailed bathymetry
  - Complete coverage from 170ft to 1200ft MLLW
  - Identifying any non-homogenous objects
  - Locating evidence of the LA-5 Disposal Site
  - Collection of Backscatter across the entire survey area
  - Successful interpretation of the backscatter
- Outfall Pipe Identified
- Sediment Mounds and Features interpreted from backscatter
- Large subsea canyon identified

	HYDROGRAPHIC SURVEY	Doc: BATT_2018_LA5_REPORT_OF_SURVEY_A3	
		Rev: A3	Date: 12/20/2018
		Page: 36 of 37	

## 7. DELIVERABLES AND MOVING FORWARD

The following data was delivered prior to this report:

- A PDF plot of the survey area with bathymetry backscatter and features
- Powerpoint Overview Presentation
- Images of Objects and Features
- Sediment Extents in the following formats;
  - DXF
  - Shapefile
- Geotiff of the Bathymetry at 20x20ft grid size
- Gridded bathymetry data as 40x40ft XYZ (ASCII text file .xyz)

	HYDROGRAPHIC SURVEY	Doc: BATT 2018 LA5 REPORT OF SURVEY A3	
		Rev: A3	Date: 12/20/2018
		Page: 37 of 37	

## Disclaimer

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